

DARPA Network Modeling and Simulation (NMS) Technology



***SPAWAR
Systems Center
San Diego***

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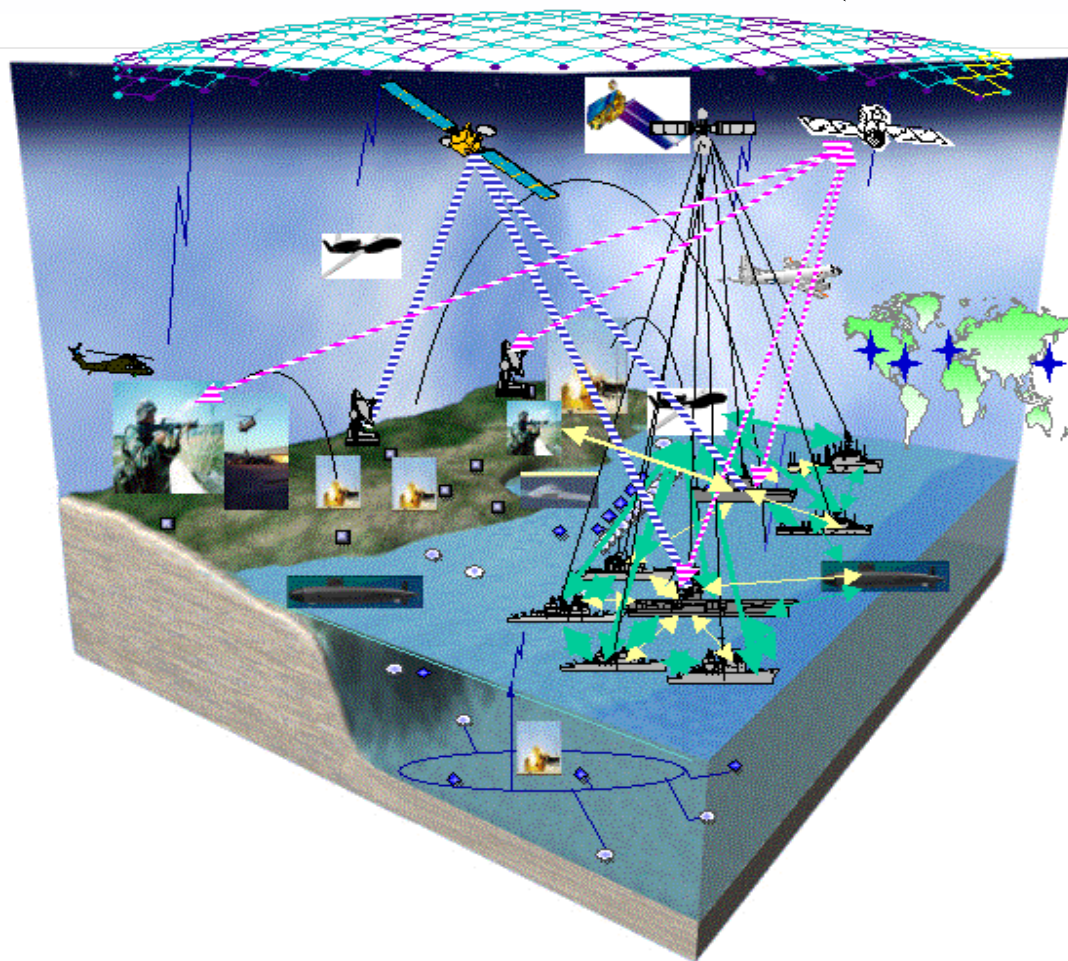
Outline

- **Overview**
- **DARPA Technologies**
 - **Georgia Tech Dynamic Simulation Backplane**
 - **Georgia Tech Network Simulator**
 - **UCLA Maya**
 - **UC Berkeley Smart Network's Toolkit**
- **Putting It All Together**



Network Centric Warfare (NCW)

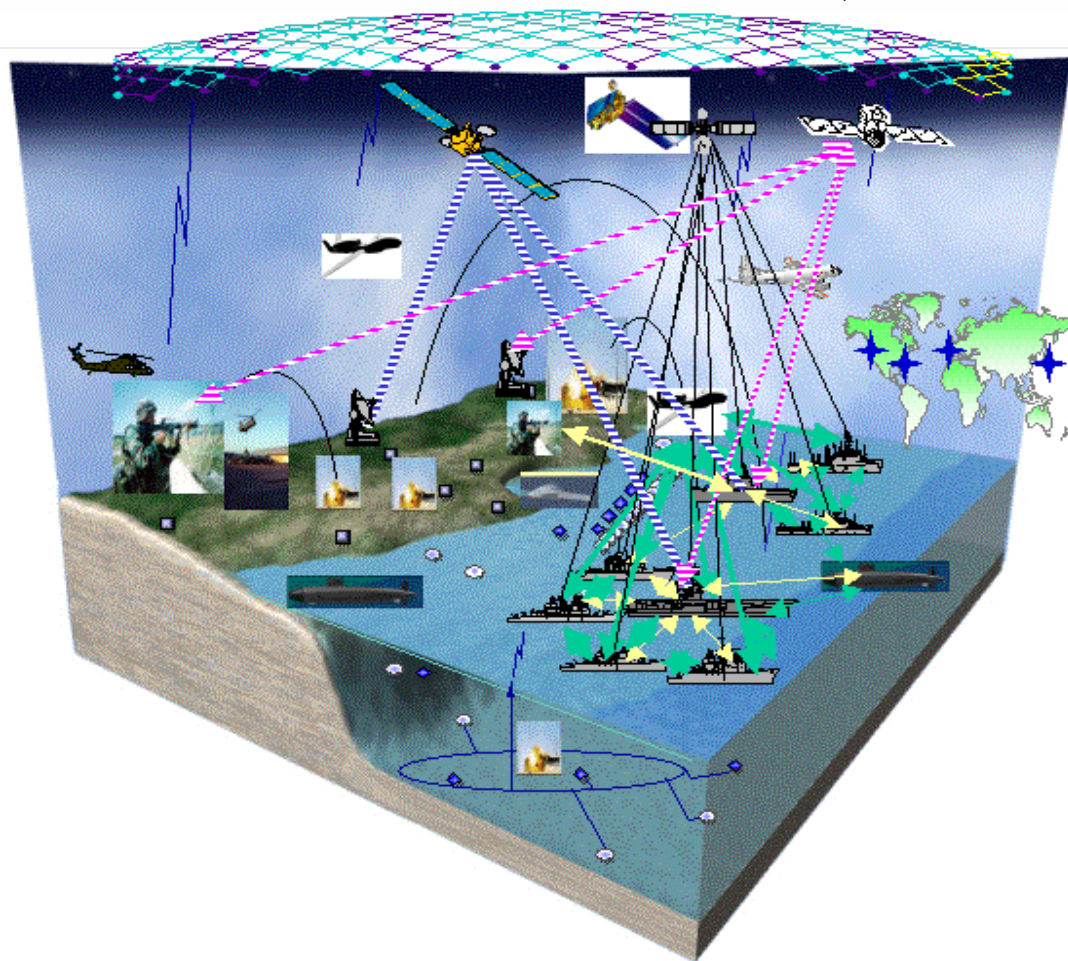
Operational Network



- **The Power of NCW**
 - Networks, sensors, resources and weapons netted together to enable information superiority
 - Information superiority allows information shared across the entire battle space to provide the warfighters superior situation awareness for faster decision making than the enemies

Challenges of Navy Networks

Operational Network



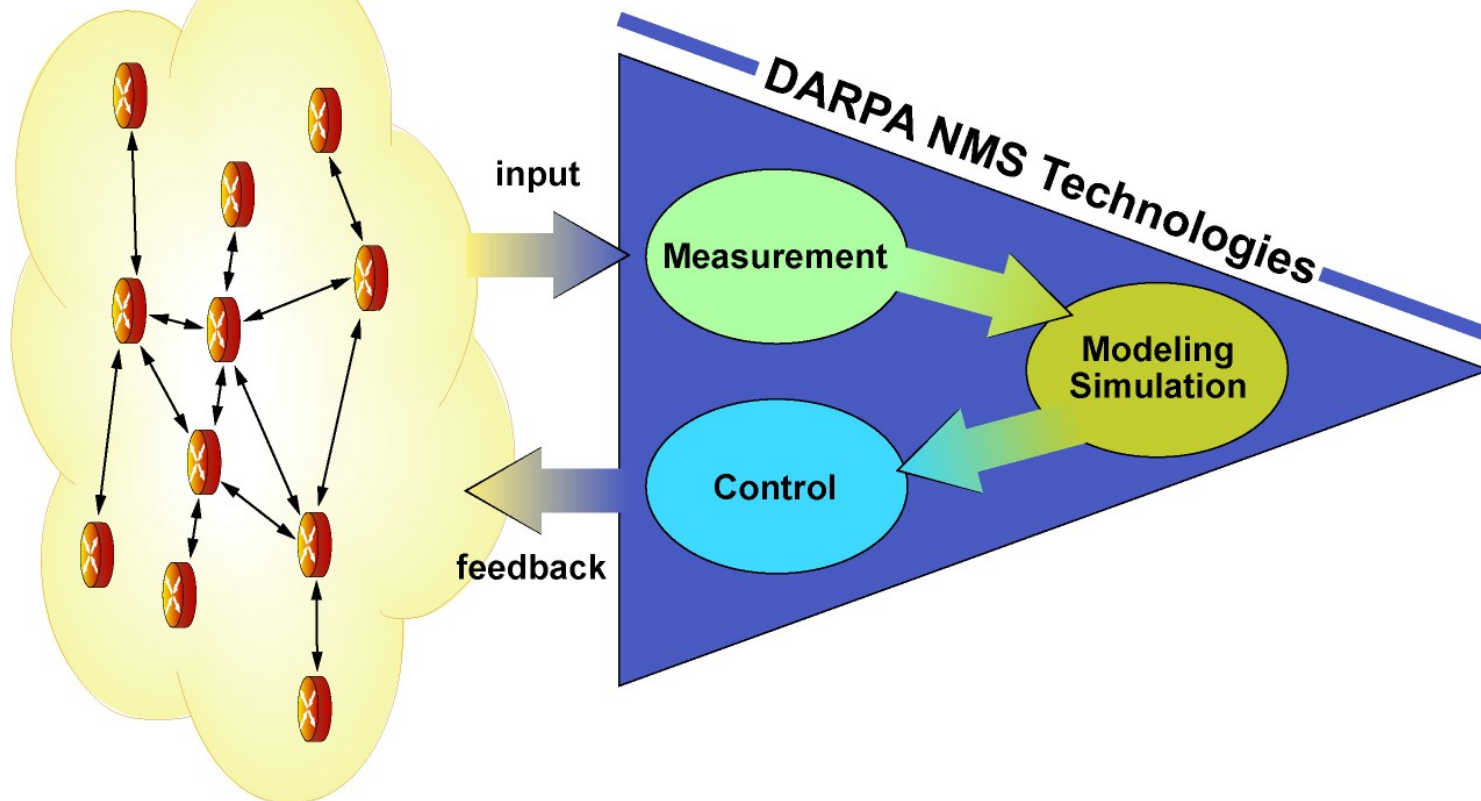
- Navy networks are increasing in complexity:
 - Becoming large in size
 - Unpredictable under various conditions
 - Dynamic: nodes movement, configuration changes, new technologies insertion, etc.
- Lack the capabilities for real-time analysis, prediction, feedback control and self-healing



DARPA NMS Technologies

Goal: Provide fast online measurement, analysis, prediction, optimization and automated control in support planning and execution of operational networks in real time.

Operational Network





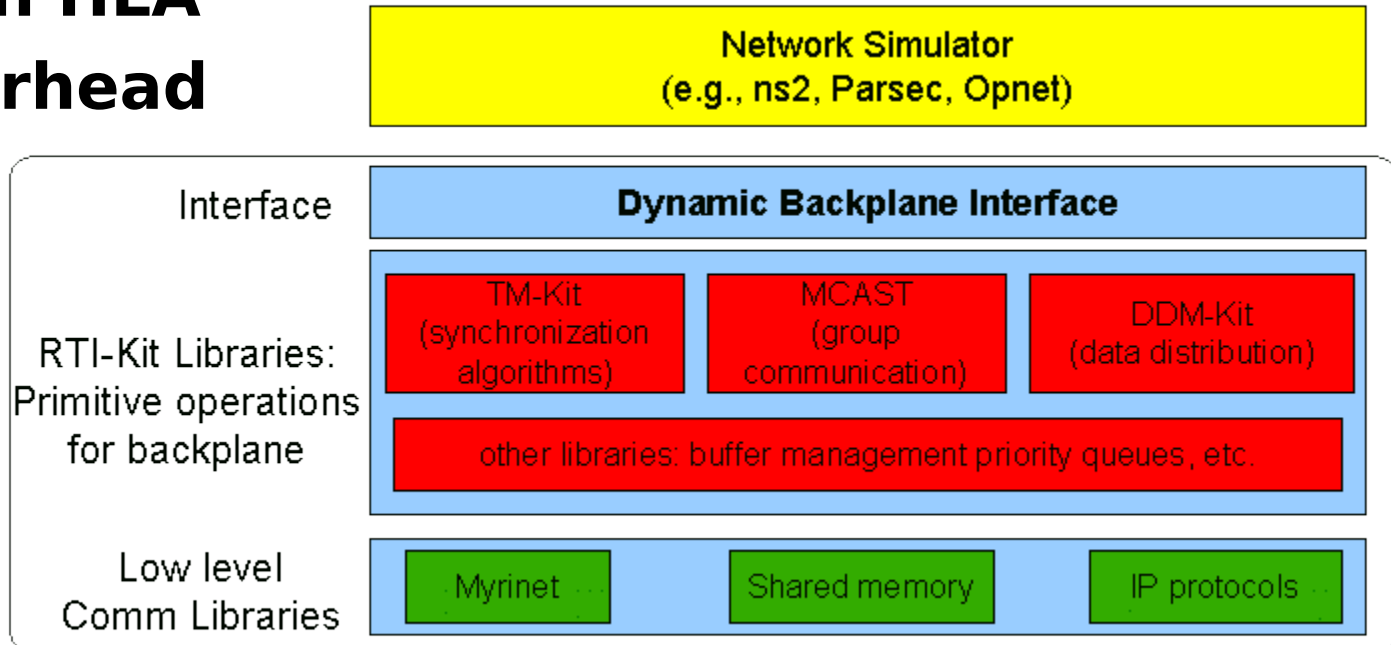
Georgia Tech Dynamic Simulation Backplane

- **Motivation**
 - **Several network simulators with different strengths and weaknesses**
 - **Distributed simulations**
 - **Reuse existing models**



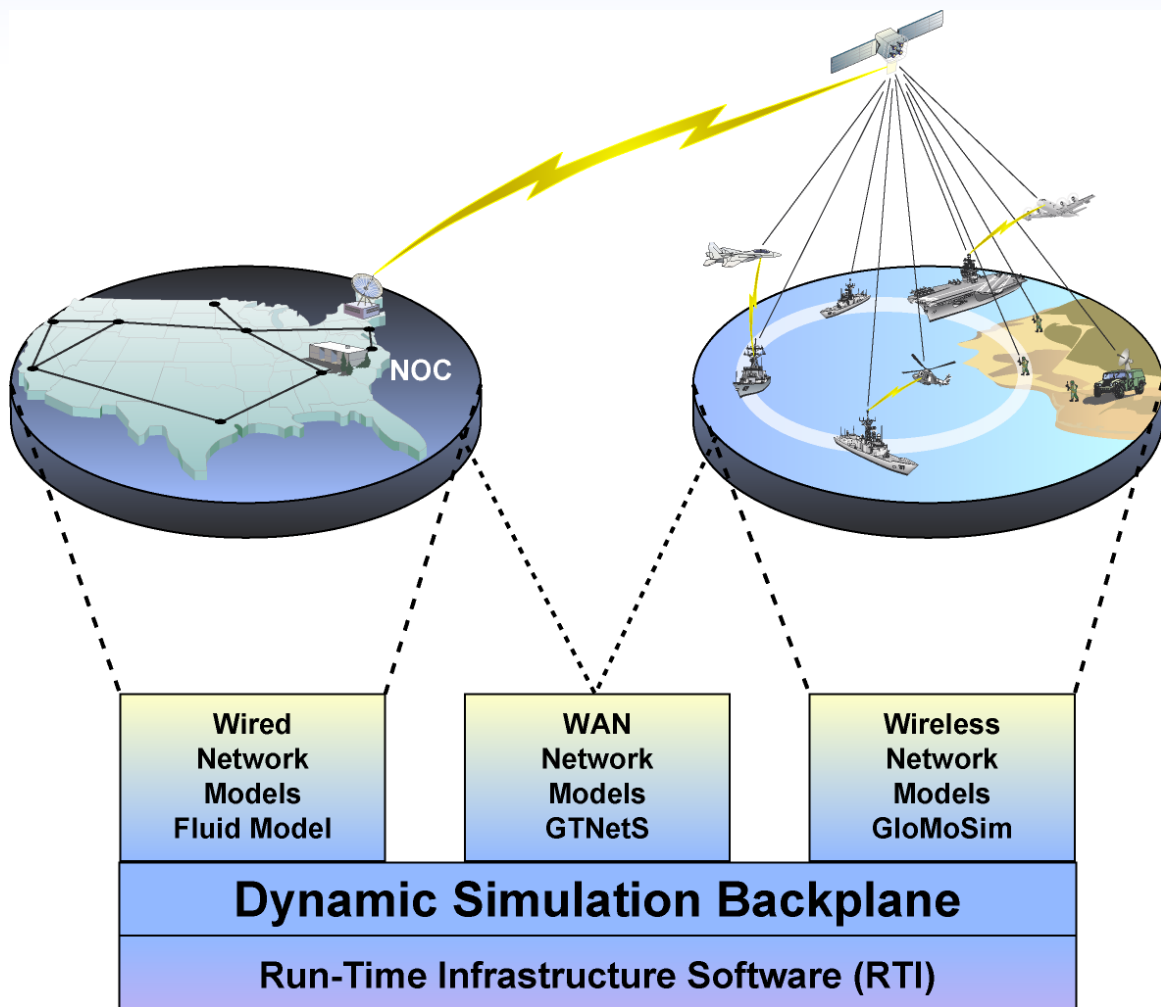
Backplane Architecture

- **Message exchange between simulators**
 - **Protocol**
 - **Services**
- **Simulator synchronization**
- **Based on HLA**
- **Low overhead**



Backplane Configuration

- **Flexibility**
 - Exploit the strength of each simulator
 - Use a different network simulators for different portions of the network model





Backplane Configuration

TCP/IP Stack

TCP/IP Stack

Application (HTTP)

Application (HTTP)

Transport (TCP)

Transport (TCP)

NS-2

Backplane (Split Protocol Stack)

Internet (IP)

Internet (IP)

Data link (MAC 802-11)

Data link (MAC 802-11)

GloMoSim

The Split Protocol Stack allows spanning large network configurations into individual layers of protocol stacks.



Georgia Tech Network Simulator (GTNetS)

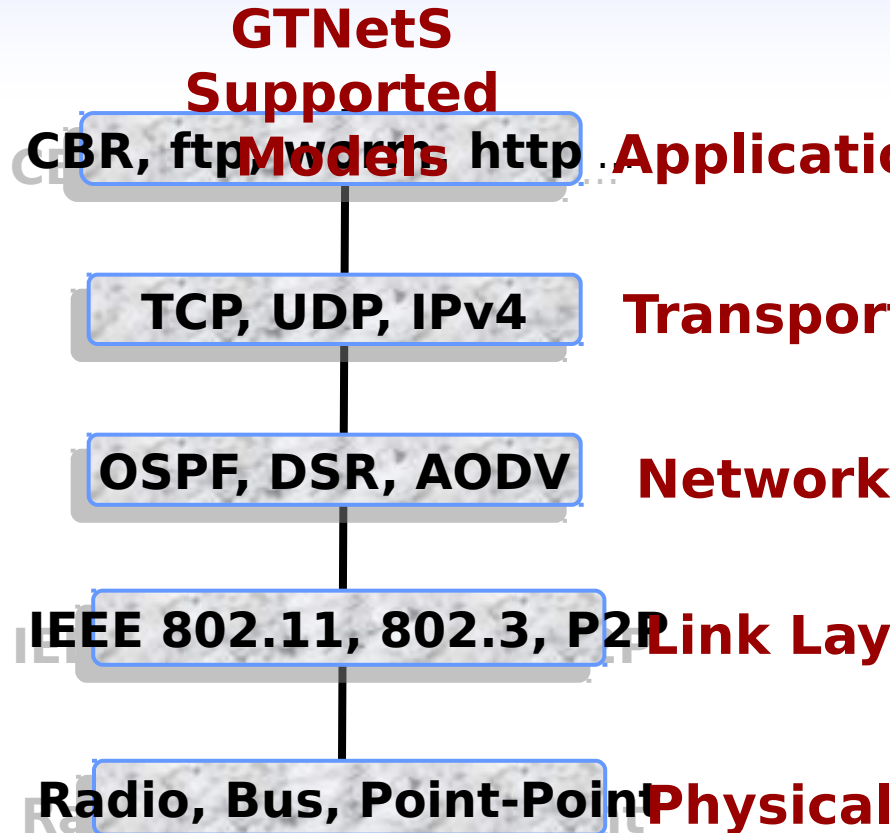
- **Motivation**

- **Navy networks are becoming larger and faster**
- **Use a network simulator designed for parallel, distributed, and large simulations to simulate Navy networks**



GTNetS Architecture

- **Designed for large simulations**
 - Reduced event list
 - Memory management
 - Reduced log file
- **Designed for parallel and distributed simulations**
 - Ghost Nodes
 - Dynamic Simulation Backplane
- **OSI Features**





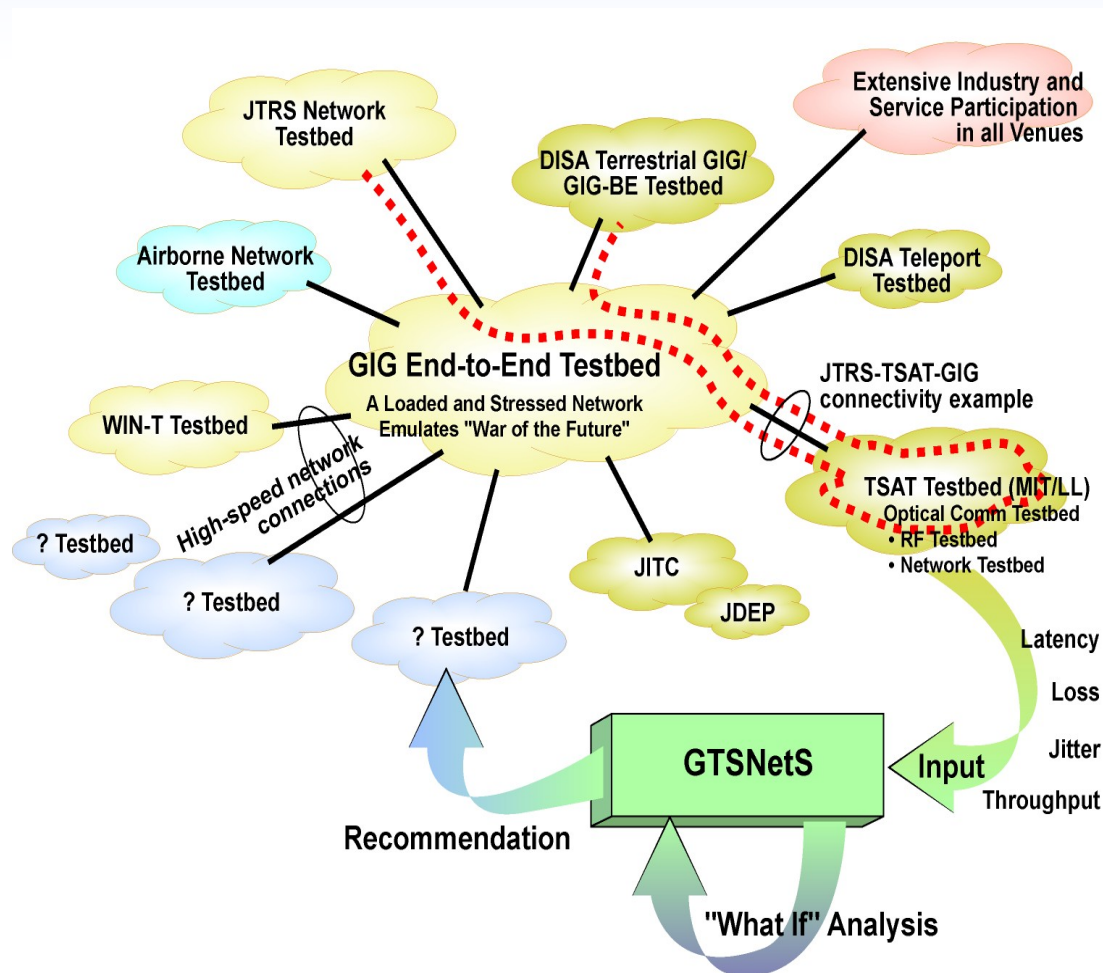
GTNetS Scalability Results

- **Pittsburgh Supercomputer Center - 32 Systems, 128 CPU's, 64-bit HP Systems**
 - **15,064 Nodes per System**
 - **482,048 Nodes Total Topology**
 - **455,168 Total Flows**
 - **4,662,689,280 Simulation Events**
 - **869 Seconds Execution Time**



GTNetS Configuration

- Predict the impact of future network performance
- Evaluate the impact of network changes
- Recommend the best configurations to reduce the impact of discontinuities and improve performance



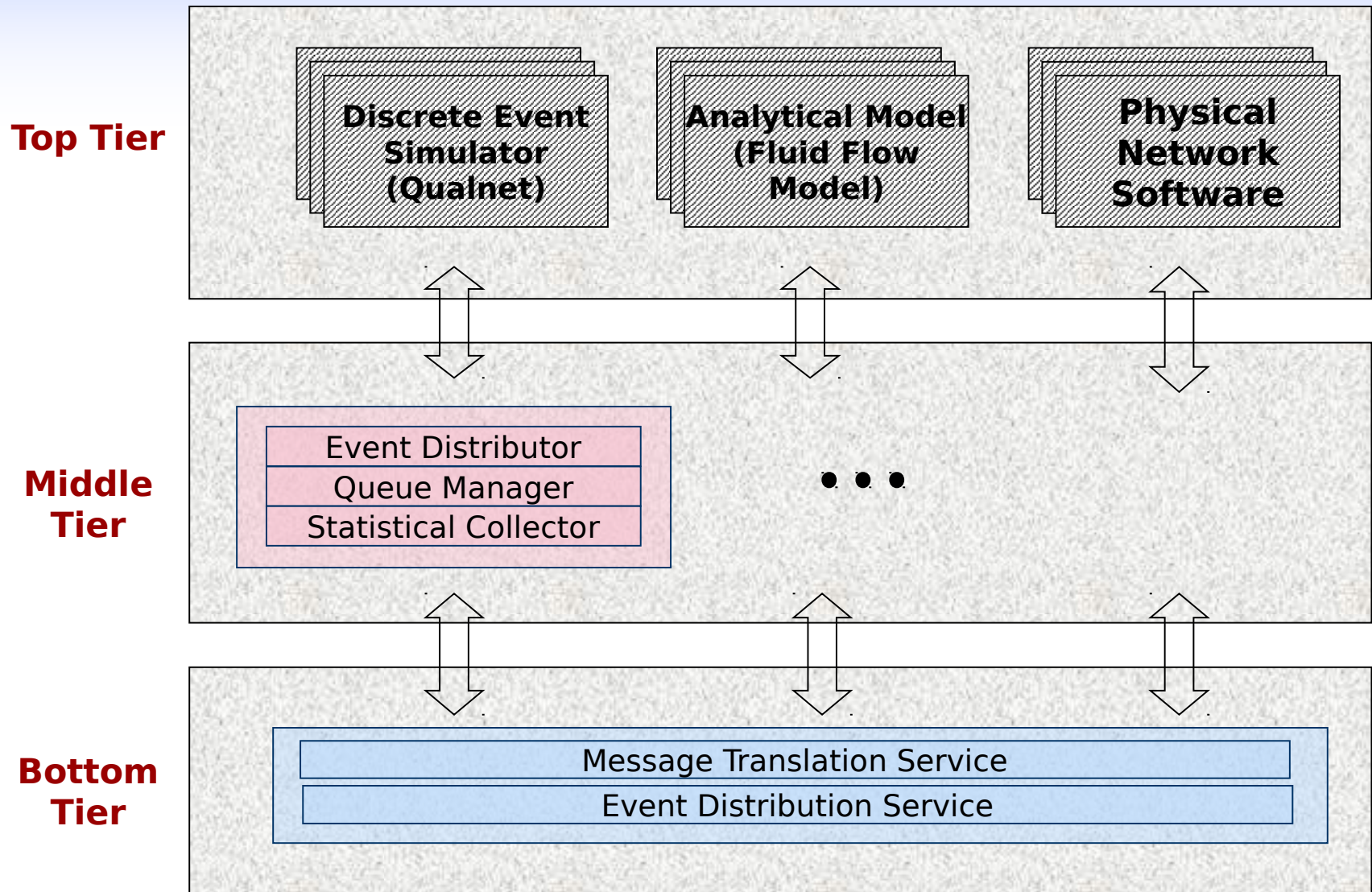


UCLA Maya

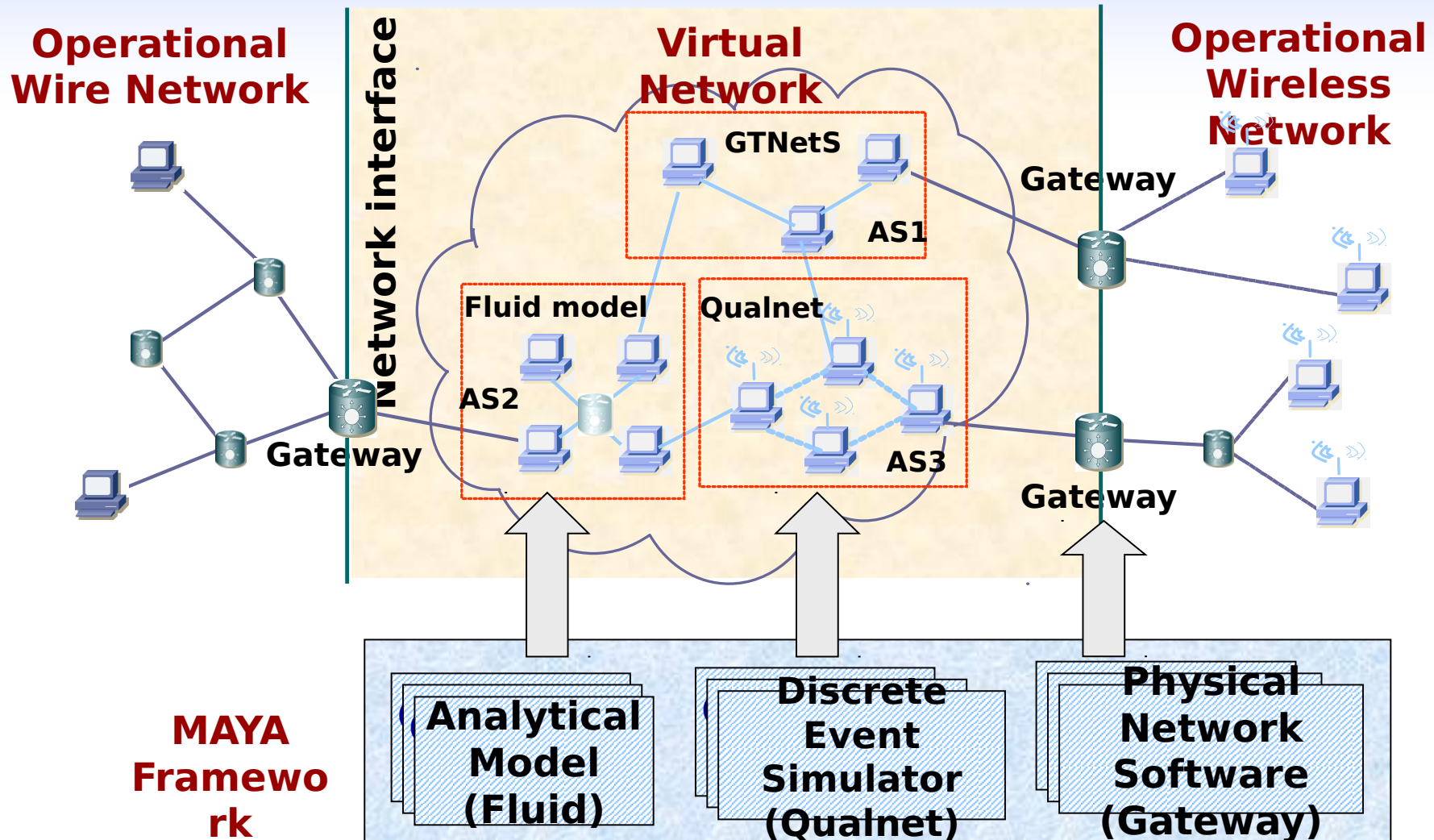
- **Motivation**

- **Navy networks are becoming larger and faster**
- **Combine discrete event models, analytical models, and physical network interfaces to simulate large navy networks**

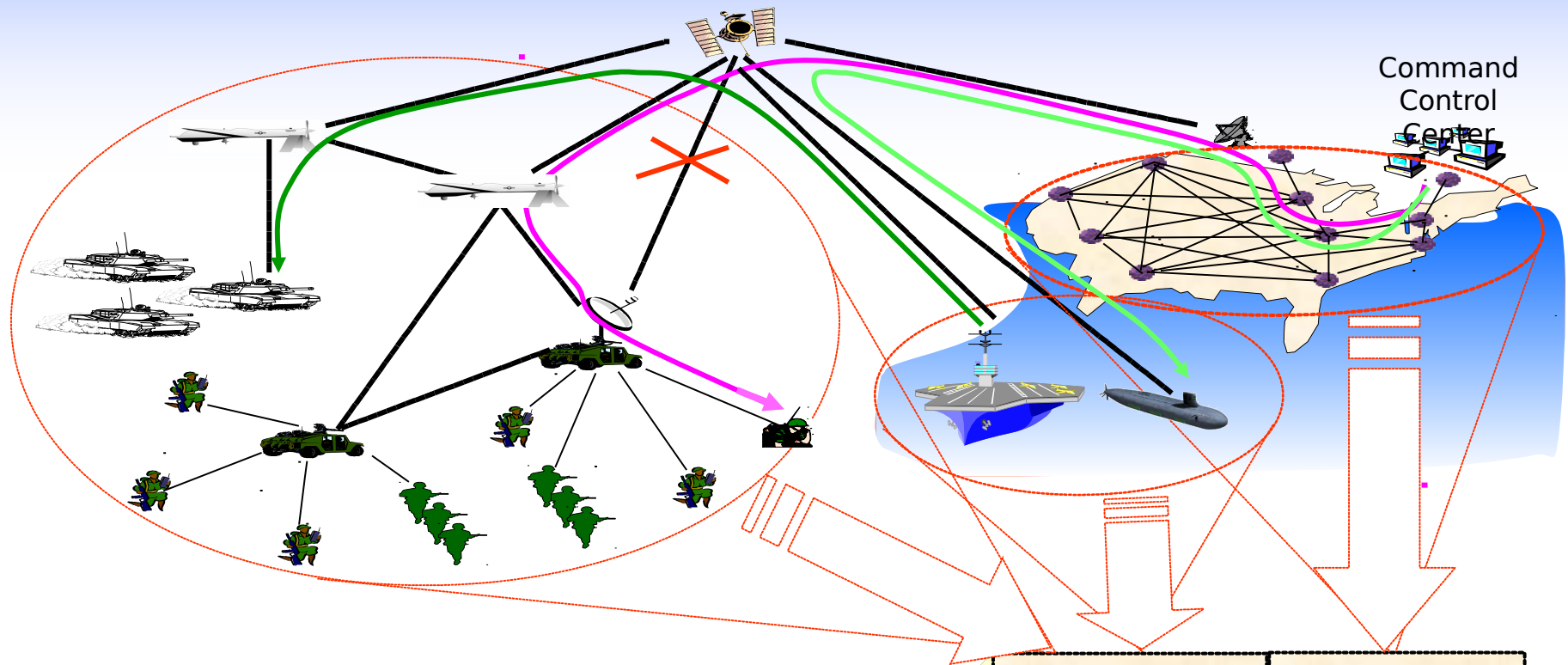
Maya Architecture



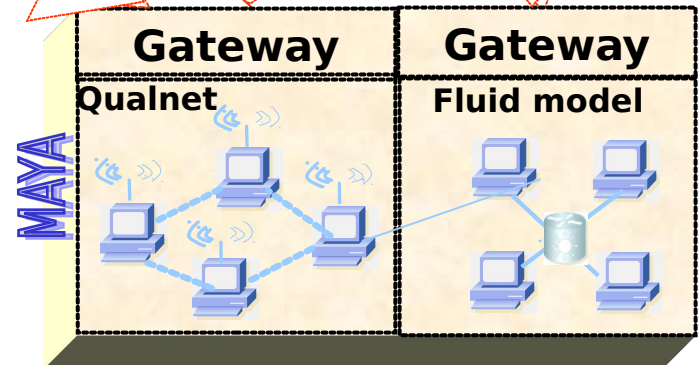
Maya Configuration



Maya Configuration



- **Assesses the impact of network dynamics on the performance of distributed applications across large scale networks**
- **Fast execution to accommodate real-time constraints**
- **Accuracy in resembling the target network**
- **Scalability in evaluation of distributed applications over large scale networks**



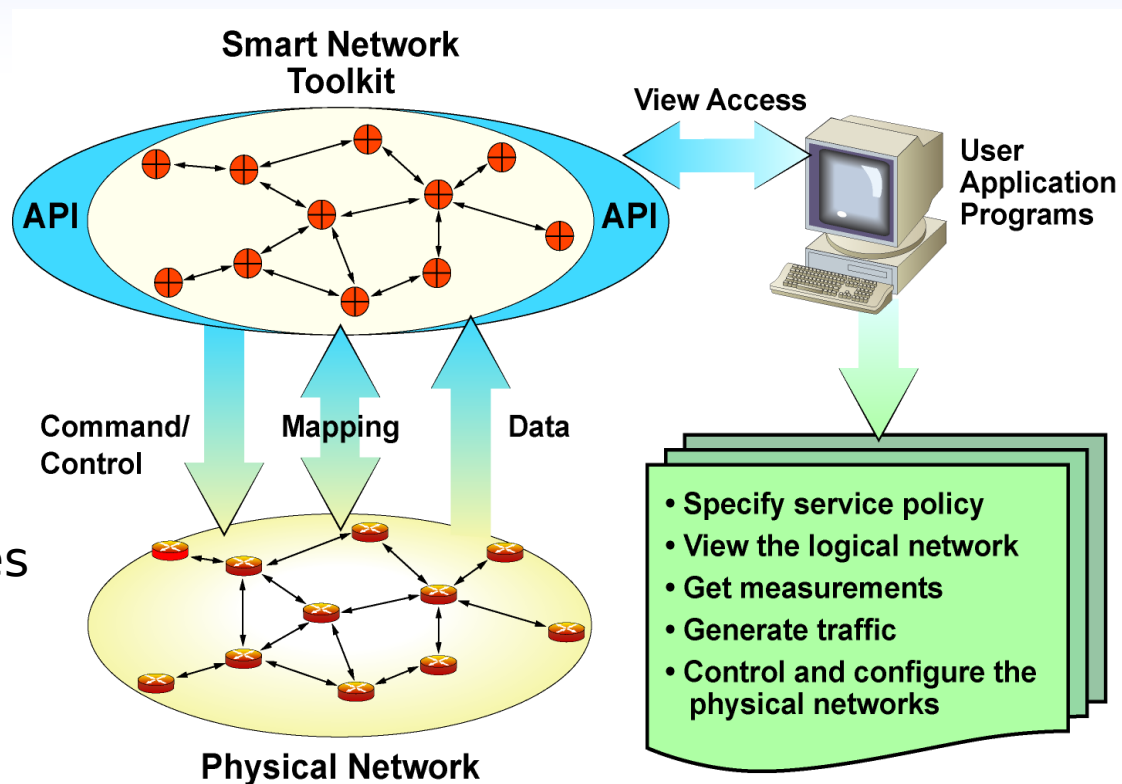


Berkeley Smart Network's Toolkit (SNT)

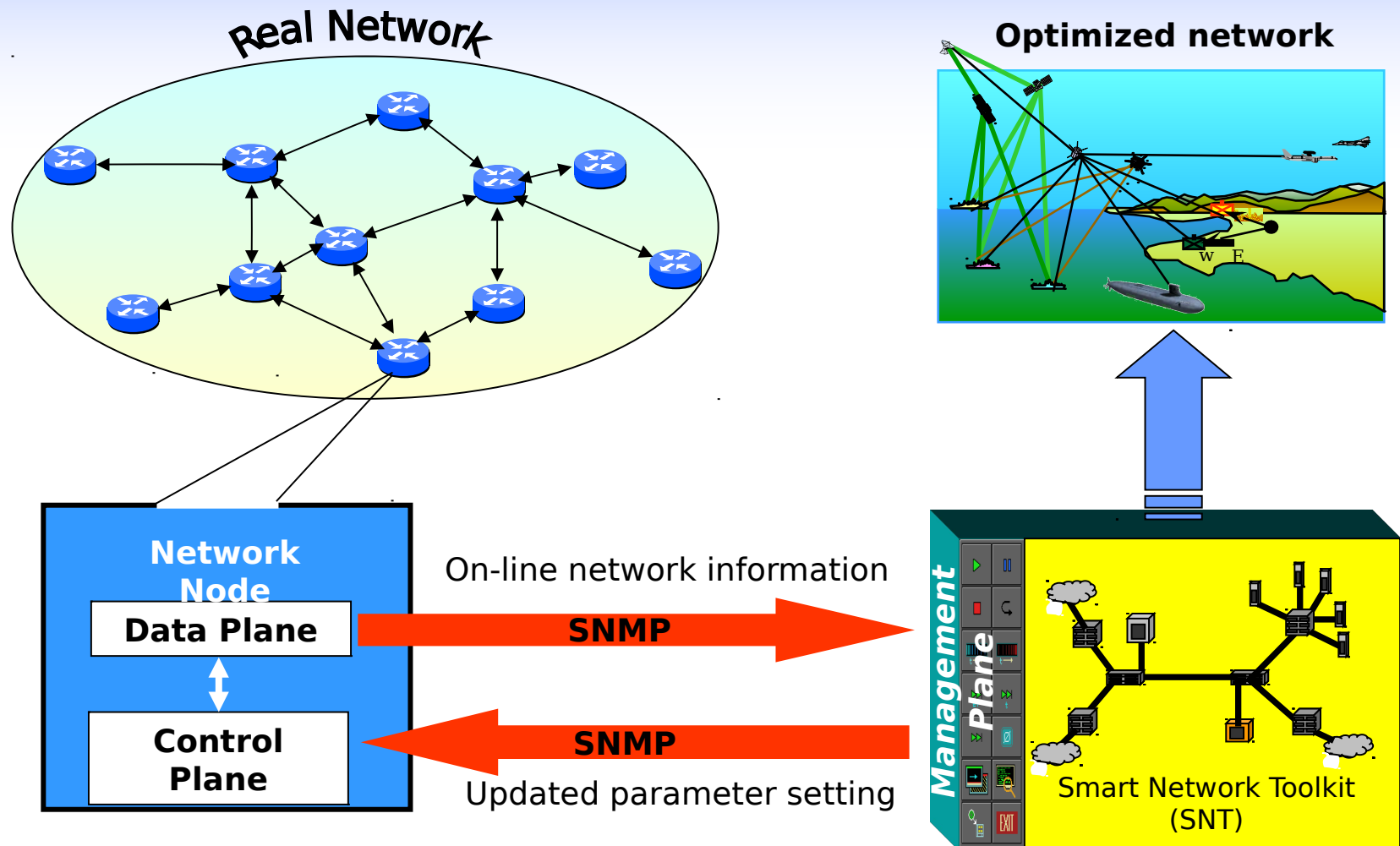
- **Motivation**
 - **Navy networks are unpredictable and dynamic**
 - **Complexity of Navy networks makes manual configuration difficult**

SNT Architecture

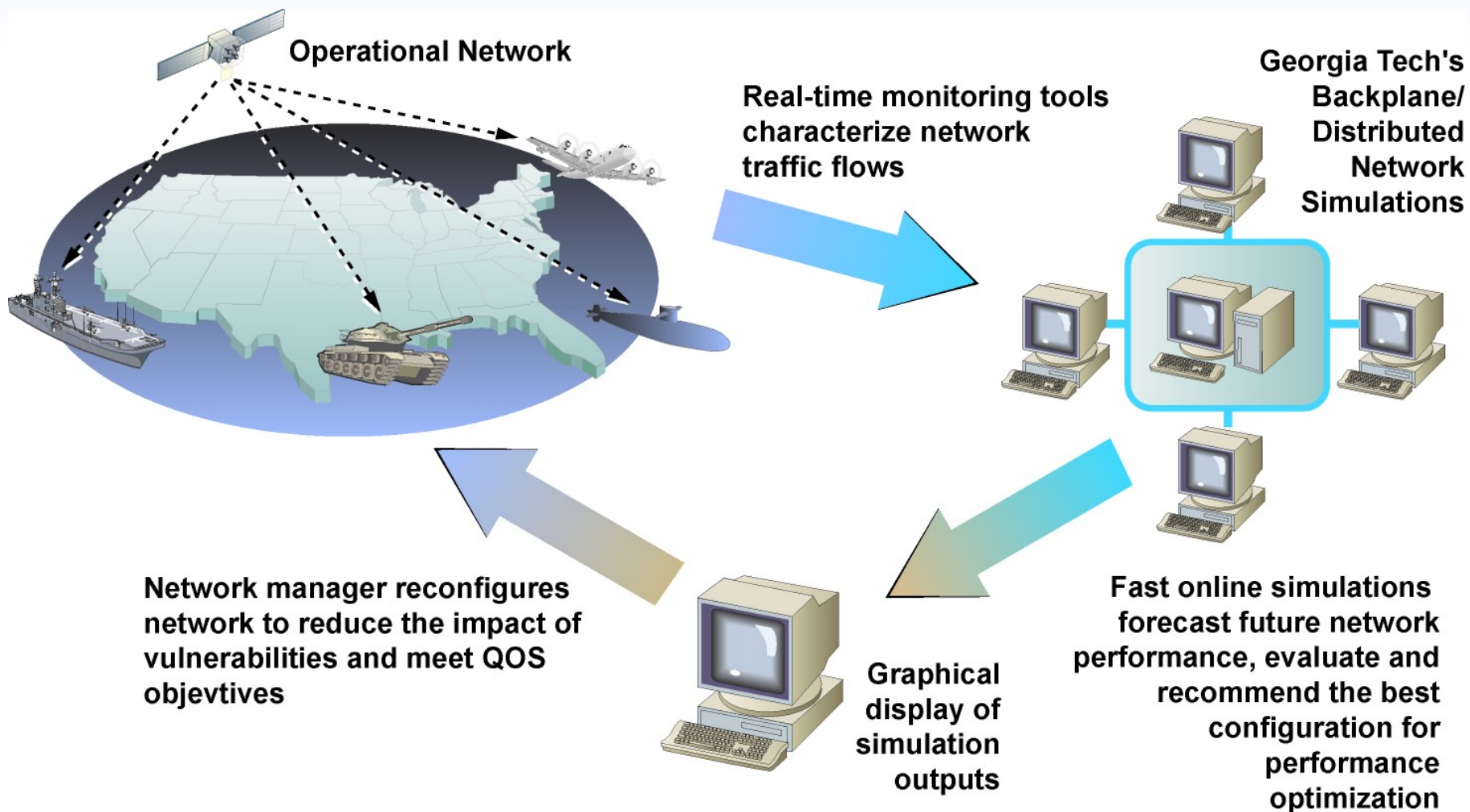
- Policy-based Network Management
 - Develop policies that describe desired network performance
 - Baseline current network performance
 - Determine if network design can meet required policies
- Translate policies into individual device-configuration changes
- Report if policies are being met



SNT Configuration



Putting It All Together





Summary

DARPA provides the tools to facilitate interoperability, synchronized execution, online analysis and planning, and management of heterogeneous networks to support geographically dispersed warfighters in an Network Centric Warfare environment

